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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/816,694	03/23/2001	Shabbir Ahmed	051583:0249	5216

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EXAMINER	
RIDLEY, BASIA ANNA	

ART UNIT	PAPER NUMBER
1764	

DATE MAILED: 03/25/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/816,694	Applicant(s) AHMED ET AL.	
	Examiner Basia Ridley	Art Unit 1764	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 February 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16 and 18-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16 and 18-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claim(s) 1-16 and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Krumpelt et al. (USP 5,929,286) in view of Ahmed et al. ("Catalytic Partial Oxidation Of Hydrocarbon Fuels") or Kumar et al. (The Low Temperature Partial Oxidation Reforming Of Fuels For Transportation Fuel Cell Systems").

Regarding claim 1, Krumpelt et al. discloses a method for generating H_2 rich gas from a fuel comprising:

- supplying to a fuel processor a mixture of molecular oxygen, fuel, and water (C3/L11-20);
- wherein the molar ratio of molecular oxygen supplied to the fuel processor per mole of fuel is x and has a value ranging from about $0.5x_0$ to about $1.5x_0$ (C3/L16-19 and C3/L34-35);
- converting the mixture of molecular oxygen, fuel and water in the fuel processor to the H_2 rich gas (C3/L42-C4/L2); wherein
- the fuel has the formula $C_nH_mO_p$, where n has a value ranging from 1 to 20 and is the average number of carbon atoms per molecule of the fuel, m has a value ranging from 2 to 42 and is the average number of hydrogen atoms per molecule of the fuel, p has a value ranging from 0 to 12 and is the average number of oxygen atoms per molecule of the fuel (C3/L11-12).

While the reference discloses that disclosed method provides hydrogen fuel for fuel cells in automotive industry (C1/L15-40) and that the reaction should be performed at low temperatures to optimize hydrogen production (C3/L42-C4/L2), the reference does not explicitly

disclose the step of determining a thermoneutral point for the fuel prior to or during the production of hydrogen.

Both, Ahmed et al. and Kumar et al. teach that it was known in the art at the time of the invention that to determine the thermoneutral points for fuel prior to or during the production of hydrogen and to control the process to operate at a low value of x (the overall reaction is exothermic but only very slightly and therefore the reaction temperatures are kept relatively low) because such operation favors higher hydrogen yields and concentrations (see: Ahmed et al., page 242, 3rd full paragraph and Kumar et al., page 751, section titled "Argonne's Partial Oxidation Reformer for Methanol").

Therefore, it would have been obvious to one having ordinary skill in the art at the time of the invention to modify the process of Krumpelt et al., as taught by Ahmed et al. or Kumar et al., by determining the thermoneutral point for fuel prior to or during the production of hydrogen and by controlling the process to operate at a low value of x (the overall reaction is exothermic but only very slightly) for the purpose of favoring higher hydrogen yields and concentrations and keeping the reaction temperature low, which also optimizes hydrogen production.

While neither Ahmed et al. nor Kumar et al. explicitly disclose the specific equation for calculating the thermoneutral point which is recited in instant claim 1, they provide both, the motivation and the method, for an ordinary artisan to derive said equation. Specifically, Ahmed et al. sets forth a balanced chemical equation for partial oxidation of a hydrocarbon with oxygen and steam and teaches the importance of one specific parameter "x" which is a molar ratio of oxygen to fuel. The reference also sets forth a general range where "x" should fall for both, partial oxidation and steam reforming, to occur together and teaches that partial oxidation reactor

should be operated in a manner that the overall reaction is exothermic but at a low value of "x" (see Ahmed et al., page 242, 3rd full paragraph). Similarly, Kumar et al. teaches that the energy released or absorbed by partial oxidation of a hydrocarbon with oxygen and steam depends on parameter "x". Kumar et al. sets forth a balanced chemical equation for partial oxidation of methanol with oxygen and steam and teaches three values of "x" for that specific hydrocarbon - one at which the reaction becomes exothermic partial oxidation, second one at which the reaction becomes endothermic steam reforming and a third one - a thermoneutral point which falls in between said two first values of "x". The reference also teaches that methanol partial oxidation reactor should be operated with "x" slightly higher than needed for thermo-neutrality (Kumar et al., page 751, section titled "Argonne's Partial Oxidation Reformer for Methanol").

Based on said disclosure, one having ordinary skill in the art at the time of the invention would be motivated to determine a thermoneutral point for other hydrocarbons which can be used for partial oxidation with oxygen and steam (e.g. methane, see Krumpelt et al., C3/L35). Since, by definition, at thermoneutral point the heat of reaction is zero, simply entering heats of formation for compounds in the balanced chemical equations of Ahmed et al. or Kumar et al., setting them equal to zero (using well known thermodynamic principles), and solving for value "x" would result in equation for calculating "x" at thermoneutral point. Thus derived equation would be the same as equation recited in instant claim 1.

Regarding claims 2-11, 14-16 and 18-20, Krumpelt et al. in view of Ahmed et al. or Kumar et al. discloses all of the claim limitations as set forth above. Additionally Krumpelt et al. discloses the method wherein:

- converting the mixture of molecular oxygen, fuel and water in the fuel processor to the H_2

rich gas further comprises contacting the mixture of molecular oxygen, fuel and water with a catalyst in the fuel processor to produce the H_2 rich gas (C3/L11-C4/L2);

- x has a value ranging from about x_0 to about $1.5x_0$ (C3/L16-19 and C3/L34-35);
- the molar ratio of water supplied to the fuel processor per mole of fuel is a value ranging from about 0.8(2n - 2x - p) to about 2.0(2n - 2x - p), (C3/L16-19 and C3/L34-35);
- the molar ratio of water supplied to the fuel processor per mole of fuel is a value ranging from about 0.9(2n - 2x - p) to about 1.5(2n - 2x - p), (C3/L16-19 and C3/L34-35);
- the molar ratio of water supplied to the fuel processor per mole of fuel is a value ranging from about 0.95(2n - 2x - p) to about 1.2(2n - 2x - p), (C3/L16-19 and C3/L34-35);
- the molecular oxygen is supplied to the fuel processor in a mixture of gases comprising N_2 and molecular oxygen (C1/L22-30 and C2/L52-67);
- the molecular oxygen is supplied to the fuel processor as air (C1/L22-30 and C2/L52-67);
- the fuel is selected from the group consisting of methane, methanol, ethane, ethylene, ethanol, propane, propene, i-propanol, n-propanol, butane, butene, butanol, pentane, pentene, hexane, cyclohexane, cyclopentane, benzene, toluene, xylene, natural gas, liquefied petroleum gas, iso-octane, gasoline, kerosene, and diesel (C1/L44-57, C2/L3-5, C3/L11-12, C3/L28-35);
- the fuel is selected from the group consisting of methane, natural gas, propane, methanol, ethanol, LPG, gasoline, kerosene, and diesel (C1/L44-57, C2/L3-5, C3/L11-12, C3/L28-35);
- x has a value ranging from about $0.8x_0$ to about $1.4x_0$ (C3/L16-19 and C3/L34-35);
- x has a value ranging from about $0.9x_0$ to about $1.3x_0$ (C3/L16-19 and C3/L34-35);
- the molar ratio of molecular oxygen supplied to the fuel processor per mole of fuel is x and has a value ranging from about $0.95x_0$ to about $1.2x_0$ (C3/L16-19 and C3/L34-35);

- the molar ratio of water supplied to the fuel processor per mole of fuel is a value ranging from about 1.0(2n - 2x - p) to about 1.1(2n - 2x - p), (C3/L16-19 and C3/L34-35);
- the catalyst comprises a two part catalyst comprising a transition metal and an oxide-ion conducting portion, and the mixture of molecular oxygen, fuel, and water is contacted with the catalyst at temperature of 400°C or greater (C1/L58-C2/L2, C2/L43-C3/L44);
- the transition metal is selected from the group consisting of platinum, palladium, ruthenium, rhodium, iridium, iron, cobalt, nickel, copper, silver, gold, and mixtures thereof, and the oxide-ion conducting portion of the catalyst is $LaGaO_3$ (C1/L58-C2/L2 and C2/L43-65);
- the catalyst is selected from the group of autothermally reforming catalysts that operate at a temperature ranging form about 100°C to about 700°C (C3/L11-C4/L2).

Regarding claims 12-13, Krumpelt et al. in view of Ahmed et al. or Kumar et al. discloses all of the claim limitations as set forth above. Additionally the reference discloses the method wherein the fuel process or is maintained at a temperature of from about 100°C to about 900°C and from about 400°C to about 700°C. While the reference does not explicitly disclose the fuel processor comprising a reforming portion, presence of said portion is inherent in a fuel processor where hydrocarbon fuel reacts with water.

3. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Krumpelt et al. (USP 5,929,286) in view of Ahmed et al. ("Catalytic Partial Oxidation Of Hydrocarbon Fuels") or Kumar et al. (The Low Temperature Partial Oxidation Reforming Of Fuels For Transportation Fuel Cell Systems"), as applied to claim 2 above, and further in view of Collins et al. (USP 5,458,857).

Regarding claim 21, Krumpelt et al. in view of Ahmed et al. or Kumar et al. discloses all

of the claim limitations as set forth above. Additionally the reference discloses the hydrogen production method, as set forth above, wherein hydrogen rich gas is produced for use in fuel cells (C1/L15-21). Further, Krumpelt et al. discloses that the hydrogen rich gas produced by the disclosed method comprises carbon monoxide (C3/L42-C4/L2). But the references do not explicitly disclose any steps to further purify produced hydrogen rich gas.

Collins et al. teaches a method for production of hydrogen for use in fuel cells (C1/L5-10) by reforming hydrocarbon fuels. Carbon monoxide is removed from produced hydrogen rich gas by contacting the hydrogen rich gas with a second catalyst effective at converting carbon monoxide and water into carbon dioxide and H_2 to produce a second gas further enriched in hydrogen and with a reduced level of carbon monoxide (abstract). Further the reference teaches that removing carbon monoxide is beneficial in hydrogen production for fuel cells not only because it recovers additional hydrogen but also because it protects fuel cells from CO poisoning (C2/L18-29).

It would have been obvious to one having ordinary skill in the art at the time of the invention to contact the hydrogen rich gas produced by the method of Krumpelt et al. in view of Ahmed et al. or Kumar et al. with a second catalyst effective for converting carbon monoxide and water into carbon dioxide and H_2, as taught by Collins et al., for the purpose of improving process efficiency by recovering additional hydrogen and for the purpose of improving fuel cell operation by removing carbon monoxide which is poisonous to fuel cell catalyst.

4. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Krumpelt et al. (USP 5,929,286) in view of Ahmed et al. ("Catalytic Partial Oxidation Of Hydrocarbon Fuels") or Kumar et al. (The Low Temperature Partial Oxidation Reforming Of Fuels For Transportation

Fuel Cell Systems"), further in view of Collins et al. (USP 5,458,857), as applied to claim 21 above, and further in view of Ohata et al. (USP 4,708,946).

Regarding claim 22, Krumpelt et al. in view of Ahmed et al. or Kumar et al. and further in view of Collins et al. disclose all of the claim limitations as set forth above. Additionally Collins et al. discloses that the conversion of carbon monoxide and water into carbon dioxide and H_2 is performed over a suitable second catalyst (C4/L43-49). While the Collins et al. teaches some exemplary suitable catalysts (e.g. C5/L41-44) the reference does not explicitly disclose any other suitable catalysts.

Ohata et al. teaches a catalyst comprising a transition metal on cerium oxide or on ceria doped with a rare earth metal or an alkaline earth element, wherein the transition metal is selected from the group consisting of platinum, palladium, nickel, iridium, rhodium, cobalt, copper, gold, ruthenium, iron, silver and combinations thereof, the rare earth element is selected from the group consisting of gadolinium, samarium, yttrium, lanthanum, praseodymium and combinations thereof, and the alkaline earth element is selected form the group consisting of magnesium, calcium, strontium, barium and combinations thereof (C3/L38-50 and C4/L26-32). The reference teaches that said catalyst has "an outstanding ability to (...) promote water gas shift reaction" (C4/L26-32).

It would have been obvious to one having ordinary skill in the art at the time of the invention to use the catalyst of Ohata et al. comprising a transition metal on cerium oxide or on ceria doped with a rare earth metal or an alkaline earth element as a second catalyst effective for converting carbon monoxide and water into carbon dioxide and H_2 in the hydrogen rich gas produced by the process of Krumpelt et al. in view of Ahmed et al. or Kumar et al. and further in

view of Collins et al. since doing so would amount to nothing more than a use of a known catalyst for its intended use in a known environment to accomplish entirely expected result. An ordinary artisan would be motivated to replace catalyst of Collins et al. with a catalyst offering "outstanding" performance for the purpose of improving operation and efficiency of the process.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

Response to Arguments

6. Applicant's arguments filed on 28 February 2005 have been fully considered but they are not persuasive.

7. The Declaration filed under 37 CFR 1.132 filed on 28 February 2005 is insufficient to overcome the rejection of claims 1-16 and 18-22 under 35 U.S.C. 103(a) as set forth above because it bears on ultimate legal conclusion of obviousness, see MPEP § 716.01(c)(III). Additionally, the underlying basis for the opinion are not persuasive because Dr. Ahmed declares that once it was determined that thermoneutral point can be used to effectively determine operating conditions, said thermoneutral point was, in fact, determined using heats of formation. This concurs with examiner's position that an ordinary artisan would derive the equation recited in instant claim 1 by application of well known thermodynamic principles to the disclosure of

Ahmed et al. and Kumar et al. Dr. Ahmed's statement that determination of appropriate range for the thermoneutral point required iterative process of modeling and experimentation is not persuasive because Krumpelt et al. discloses operation at oxygen to fuel molar ratio equal to n/2 for methane (i.e. natural gas). Said ratio falls within, and therefore anticipates, the claimed range.

In view of the foregoing, when all of the evidence is considered, the totality of the rebuttal evidence of nonobviousness fails to outweigh the evidence of obviousness.

8. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

9. Regarding applicant's arguments that the Examiner can point to no teaching or suggestion in Krumpelt et al. that the molar ratio of molecular oxygen supplied to the fuel processor per mole of fuel is x and has a value ranging from about $0.5x_0$ to about $1.5x_0$ the examiner apologizes for inadvertently omitting the appropriate citation in prior Office action.

10. Regarding applicant's arguments that references taken individually do not teach the specific equation recited instant claim 1, the examiner notes that Krumpelt et al. was not relied upon to teach said equation. The examiner has, however, relied on disclosure of Ahmed et al. and Kumar et al. <u>and</u> on general knowledge available to one having ordinary skill in the art at the time of the invention to teach said equation, as set forth above.

11. Applicant's arguments that Kumar et al. does not disclose that the thermoneutral point should be determined either prior to or during the partial oxidation reaction are not persuasive.

Since Kumar et al. discloses that partial oxidation reactor should be operated at oxygen to methanol molar ratio a little higher than needed for thermal neutrality, the thermoneutral point has to be determined either before, or at least during the partial oxidation reaction for process control.

12. Regarding applicant's arguments that neither Ahmed et al. nor Kumar et al. teach range for x which is recited in instant claim 1, the examiner notes that neither Ahmed et al. nor Kumar et al. were relied upon to teach said range. The examiner has, however, relied on disclosure of Krumpelt et al. to teach said range, as set forth above.

13. Applicant's arguments that equations of Ahmed et al. and Kumar et al. are different than equation recited in instant claims are moot in view of the new grounds of rejection. Further examiner notes that argument that "instant equation for determining the thermoneutral point x_0 employs the ΔH values of the fuel and water, <u>not</u> the O_2:fuel ratio (x)" is not clear as the thermoneutral point x_0 <u>is</u> the O_2:fuel ratio (x) at which the heat of reaction is equal to zero.

14. Applicant's arguments that there is a large number parameters which need to be considered to optimize a reaction, therefore, without knowing that the thermoneutral point is of importance, an ordinary artisan would not be motivated to derive equation to calculate said thermoneutral point are not persuasive, as both, Ahmed et al. nor Kumar et al., teach that the thermoneutral point could serve as an important point for determining operating conditions.

Conclusion

15. In view of the foregoing, none of the claims are allowed.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Basia Ridley, whose telephone number is (571) 272-1453.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Glenn Caldarola, can be reached on (571) 272-1444.

The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Technical Center 1700 General Information Telephone No. is (571) 272-1700. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Questions on access to the Private PAIR system should be directed to the Electronic Business Center (EBC) at (866) 217-9197 (toll-free).

Basia Ridley
Examiner
Art Unit 1764

BR
March 18, 2005